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Work Schedules and Health Behavior Outcomes at a Large Manufacturer

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Abstract: There is evidence that work schedules may influence rates of unhealthy behaviors, suggesting that addressing work schedule challenges may improve health. Health Risk Assessment (HRA) survey responses were collected during 2000–2008 in a multinational chemical and coatings manufacturer. Responses of 26,442 were sufficiently complete for analysis. Rates of smoking, lack of exercise, moderate to high alcohol use, obesity (BMI≥30), and short sleep duration were compared by work schedule type (day, night, or rotating shift) and daily work hours (8, 10, or 12 h). Prevalence rate ratios (RRs) were calculated, adjusting for age group, sex, marital/living status, job tenure, and occupational group. The reference group was 8-h day shift employees. Overall prevalence rates were: sleep duration of 6 h or less per night 47%, smoking 17.3%, no exercise 22.0%, BMI≥30 28.3%, and moderate to heavy alcohol consumption 22.2%. Statistically significant RRs include the following: Short sleep duration: 10 h rotating shift (RR=1.6), 12 h day and 12 h rotating shifts (RR=1.3); Smoking: 12 h day and rotating shifts (RR=1.6), 10 and 12 h night and 8 h rotating shift (RR=1.4); No exercise: 8, 10, and 12 h rotating shifts (RR=1.2 to 1.3), 12 h day schedules (RR=1.3). Obesity (BMI≥30): 8 and 10 h night shifts (RR=1.3 and 1.4, respectively).

Key words: Shift work, Circadian rhythms, Occupational health, Health behavior, Work schedule intolerance, Shift length

Introduction

Efforts to promote healthy behaviors in the workplace have increased as the costs of ill health to employers and the nation become better recognized[1–5]. At the same time, evidence has been accumulating that work schedules may influence rates of unhealthy behaviors[6–9]. Researchers theorize that long hours (more than 8 h/d or 40 h/wk) and shift work (work that includes evening and night shifts) promote unhealthy behaviors because of physiological changes and maladaptive coping strategies linked to disturbances to sleep and circadian rhythms and stress on family and social life[10–13]. It is thought that some workers on these non-standard schedules get inadequate sleep because of time constraints and the need to sleep at unusual times of day. They may be more prone to use stimulants, including tobacco products, to overcome sleepiness and fatigue. They may also attempt to ease stresses from the job and family/social life by smoking, drinking, and overeating. Poor sleep leads to an imbalance in appetite hormones that increase feelings of hunger and stimulate over eating[12]. Non-standard schedules have also been thought to reduce access, both physically and socially, to opportunities for exercise and healthy foods[6].

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Better understanding of relationships between work schedules and health behaviors could help guide design of work schedules and identify special challenges that some workers may face in adopting healthy behaviors. This study examined associations between work schedules and health behaviors using health risk assessment employee survey data from a large, U.S.-based, multinational manufacturing company. The 8 h day shift was compared with eight other work schedule patterns to assess relationships with smoking, exercise, body mass index (BMI[1]) (indicating in part, eating and exercise behavior), alcohol use, and sleep duration. We hypothesize that longer shifts and work during night or rotating shifts are associated with unhealthy behaviors, and that long night or rotating shifts are associated with the least healthy behaviors. However, there are some qualifications to this. Because 10 h shifts are typically associated with compressed, 4 d work weeks, they may allow more time for exercise and sleep on weekends and so could conceivably have healthier outcomes[14, 15]. The same pattern is possible, though less probable for 12 h shifts. Despite longer weekends with compressed schedules, we hypothesize that long shifts may lead to fatigue, stress, and compromised sleep on work days. The hypothesis that alcohol use is associated with nonstandard schedules is also particularly qualified, because there is a small amount of research with mixed results on the topic (see below).

Previous research

We briefly review below some of the research on the relationship between work schedules and each of the individual health-related behaviors. It is important to note that while some of this research has examined associations of behaviors with specific shift types, other research has compared day work to shift work more broadly. In addition, although we focus on hours per shift, research on the relationship between health behaviors and hours of work has focused more on total hours per week.

Work schedules and sleep

A substantial amount of research reports that shorter sleep duration is linked with high overtime hours, long work hours, and shift work. A meta-analysis of 36 studies published between 1963 and 1997 compared the hours of sleep per day of different shift work patterns. Permanent day shift workers slept an average 7.0 h per day; permanent night workers slept an average 6.6 h; rotating night workers slept the least (5.85 h) and permanent and rotating evening workers slept the longest (7.6 to 8.1 h)[16]. More recent surveys in Detroit and Catalonia in Spain found, respectively, that night workers slept 6.1 h compared to 6.8 h for day workers, and that a higher percentage of those working 51–60 h per week slept 6 h per day or less compared to those working 30–40 h per week (men: 34% vs. 25%, women: 43% vs. 27%)[17, 18].

Knauth[14] reviewed studies on the effects of shifts over 8 h. He tallied 13 studies finding negative effects on sleep or sleep quality, 8 finding mixed or no effects, and 4 finding positive effects. Studies on "sleepiness, fatigue, and alertness" found negative effects much more often than positive effects (26 negative, 10 mixed or no effects, 3 positive effects). Although Knauth sees methodological problems that prevent firm conclusions, he nevertheless advises that caution is warranted when implementing longer shifts and states they are unacceptable without proper planning and allowance for safety and health concerns. Other studies not included in Knauth's review, mainly of male, white collar, east Asian work groups, have also shown an association of overtime and high hours per day or per week, with shorter sleep hours[19–23]. In addition, a high quality study using a large, representative sample of the U.S. population[24] found an inverse relationship between work hours and sleep hours: one additional hour of work a day was associated with one half hour less sleep. A benign interpretation is that people with lower sleep needs are choosing this tradeoff, but it seems likely that the tradeoff also compromises on needed sleep

Work schedules and smoking

A review of the association of shift work and smoking reported that 6 of 13 cross-sectional studies found a positive relationship, one found a negative relationship, and 6 found no relationship[7]. In addition, two cohort studies found higher smoking rates at baseline for shift workers, although there was no observed tendency for new shift workers to increase smoking during the follow-up of up to one year[7]. Those studies finding higher smoking among shift workers reported that their smoking rates were 10 to 40% higher. Two studies of nurses, one in Finland and one in the U.S., found respectively, that long-term shift workers were more likely to smoke than long-term day workers, and that among those with shifts over 8 h , night shift nurses smoked at nearly double the rate of day shift nurses (although little difference between night and day shift was observed for those with shifts of 8 or fewer hours)[25, 26]. A more recent review identified 5 additional studies, 4 of which found a positive association[9]. Two particularly high quality studies had positive

[1]BMI is an indirect measure of body fat, defined as weight (kg) / [height (m)]^2

results: a study of a random sample of employees in 63 occupations in Sweden[27], and a 1 yr cohort study of new employees in which the smoking rate and number of cigarettes per day increased more for shift workers than for day workers[28]. Van Amelsvoort *et al*.[29] have pointed out that, in studies of cardiovascular disease and shift work, smoking has been considered to be a confounding factor, but that this is inappropriate if shift work gives rise to higher smoking rates. Their 2 yr cohort study of 45 Netherlands companies found that shift work was associated with a 46% greater number of new smokers than the day shift. In another study of new social service and health care workers, however, a greater percentage of night and evening workers smoked before taking their jobs[30].

Studies examining the relationship between long work hours and smoking appear to be fewer in number and have yielded more mixed results. A longitudinal survey of a representative Canadian sample found that a switch from 35–40 h per week to more than 40 h per week was associated with twice the probability of increased smoking among men and four times the probability of increased smoking among women[31]. In the Catalonia survey cited above, high hours per week (51–60) were also associated with higher smoking rates than were lower work hours per week (31–40) (Men: 40% vs. 33%, Women: 47% vs. 29%)[18]. However, no statistically significant relationship was found between smoking and high weekly hours in two studies of workers in Korea and Japan[20, 23].

Work schedules and exercise

Findings on the relationship between shift work and exercise have been few and mixed. Evidence for an association between shift work and lack of exercise is based partly on studies summarized by Atkinson *et al*.[6] indicating that shift work can make participation in social forms of exercise difficult. In addition, Atkinson *et al*. point out that fatigue due to demanding schedules can discourage exercise. However, a study of nurses found no tendency of those with a long history of shift work to exercise less than long term day workers[25]. A review of studies on shift work and exercise by Zhao and Turner[9] found only four additional studies, and concluded that there was little basis to draw a conclusion, except that more research is needed. Two studies that looked at high hours of work per week found no relationship with exercise[21, 31]. Other studies focusing on work hours per week reported a strong relationship[18, 19, 23], with physical activity levels about half as high, or rates of "no exercise" twice as great, for employees with high hours per week as for those on standard hours.

Work schedules and BMI

BMI is largely a function of eating and exercise behavior[32]. Possible schedule influences on exercise were just mentioned. Eating behavior is thought to be affected by shift work because of high rates of gastrointestinal complaints and altered availability of foods and participation in family meals[6]. In addition, poor sleep leads to physiological changes in appetite hormones that increase hunger and may drive workers to overeat[12]. There is no consistent evidence of higher energy intake of shift workers, but differences in timing of meals and metabolism may affect BMI[6, 9]. The research on the relationship of BMI and body weight to work schedule found an increase in weight associated with shift work[6, 9, 33–35] and with long hours per week[31, 35], although not uniformly[19, 36].

Work schedules and alcohol consumption

Several studies suggest that work schedules may influence alcohol consumption. Although a study of 700 nurses in Finland found little difference in consumption between those who had always worked nights and those who had always worked days[25], an analysis of a nationally representative sample of U.S. nurses found that high alcohol use (>5 drinks on one occasion) was about 40–50% higher among those working shifts longer than 8 h and rotating shifts compared to those working day shifts[26]. Night shift nurses had only about half the rate of high alcohol use of day shift nurses when they worked shifts 8 h or less, but a 40% higher rate when they worked shifts more than 8 h.

Shields[31] conducted a study of changes in health behaviors over a two year period in a nationally representative Canadian sample. Women who increased from 35–40 h to over 40 h/wk had a higher rate of increased drinking (average increase of 3 drinks/wk) than women who continued to work 35–40 h/wk (35% vs. 22%). However, a similar difference was not seen in men. This study also found that men on non-standard shifts had a *lower* rate of increased drinking than regular day workers. Some studies of male workers also found lower alcohol consumption among night workers[37], shift workers (not statistically significant)[28] and those working over 60 h/wk (not statistically significant)[20].

Methods

Study sample

Data from a voluntary, on-line Health Risk Assessment (HRA) survey (administered by InfoTech, Winnipeg, Canada) were collected during 2000–2008, from 30,234 employees, aged 18–74 yr, in a multinational manufacturer focused principally on chemicals and coating

products. The NIOSH Human Subjects Review Board determined that this project need not be subject to board review, because there was no interaction with human subjects, the data supplied contains no personal identifiers, and the data supplier does not release identifying information under any circumstances. The survey included required modules on a variety of health behaviors and health conditions, and optional modules on depression symptoms, work safety and ergonomic stressors, work productivity, stress, and other subjects. The survey could be taken at any time, but was periodically promoted without aid of financial incentives. The employer has over 150 sites and a stable workforce that peaked around the end of 2007 at approximately 34,000. Responses of 26,442 were sufficiently complete for analysis of most behaviors. Most of the respondents were from U.S. locations (69%) and others were located in Canada, Mexico, Europe, Australia, China, the Philippines and a variety of other countries. There were 6,530 employees who responded to a question on sleep hours which was in an optional module on stress. Participants were grouped by their work schedules: 1) 8-h day shift, 2) 10-h day shift, 3) 12-h day shift, 4) 8-h night shift, 5) 10-h night shift, 6) 12-h night shift, 7) 8-h rotating shift, 8) 10-h rotating shift, and 9) 12-h rotating shift.

Definitions of variables

The short sleep duration group was defined as those who answered that they usually get 6 h of sleep or less at night[2]. The 'BMI risk' group was defined as those whose BMI index is greater than or equal to 30. The smoking group was defined as those who answered 'Yes' to the question, 'Do you smoke now?' (This group included all users of loose tobacco) 'No exercise' was defined by an answer of "less than two times a month" to the question, "How frequently do you exercise or take part in physical activities which result in deeper breathing and an increased heart rate?" 'Moderate to heavy drinking' was defined for males as drinking 1 or more times a week and 3 drinks or more each time, and for females as drinking 1 or more times a week and 2 drinks or more each time.

Statistical methods

Day workers on 8-h shifts were compared with the other eight schedule patterns for prevalence of smoking, lack of exercise, moderate to high alcohol use, BMI over 30, and short sleep duration. The relationships between work schedule and health behaviors were also assessed by estimating adjusted prevalence rate ratios (RR) and 95% confidence intervals (95% CI). Generalized linear models with log link and a Poisson distribution assumption were employed, adjusting for occupational group, job tenure, age, sex, and marital status. Categories for these variables are listed in Table 1.

The factors used to adjust rates were those available in the data that appeared likely to be associated with differences in health behaviors and which may vary by work schedule group. Adjustment for occupational group was particularly critical, because work schedules differed dramatically by occupational mix (Table 2).

Results

Table 1 presents the distribution of the study sample by work schedule and by the variables that were used to adjust the prevalence rate ratios. About half of the sample worked shifts other than the standard 8-h day shift. About 40% of the individuals in the sample were classified as production/maintenance employees, and about 18% were in the manager/professional reference group. The sleep question respondent subsample was similarly distributed across work schedules and employee characteristics.

Prevalence rates of unhealthy behaviors for each work shift type and for the sample as a whole are reported in Table 3. Overall prevalence rates were as follows: short sleep duration, 47%; smoking, 17.3%; no exercise, 22.0%; BMI≥30, 28.3%; and moderate to heavy alcohol consumption, 22.2%.

The adjusted prevalence rate ratios (RRs) reported in Table 4 show smaller differences associated with shift type than appear in Table 3, indicating that some of the differences among shift types are associated with differences in occupational mix and other worker characteristics.

After adjusting for worker characteristics, all rotating shifts and night shifts, and day shifts over 8 h, with the exception of the 10-h night shift, showed higher prevalence of short sleep duration compared to 8-h day shifts, although the 12-h night elevation was not statistically significant. The highest rates of short sleep duration were observed for 10-h rotating shift workers (RR=1.6), and for 12-h day, night, and rotating shift workers, with RRs of 1.3 (night workers not statistically significant). A ratio of 1.3 indicates that the rate is 30% higher than the 42% rate of the 8-h day shift workers, and thus an additional 12.5% of employees on 12-h shifts with short sleep duration. This is an estimate of the elevation in rate that would be observed if the employees on these shifts had the same characteristics as employees on the 8-h day shift.

[2]The scientific consensus is that most adults need 7 to 8 h of sleep per day[38].

Table 1. Characteristics of survey respondents

		Whole study sample		Sleep question respondents	
Variable	Category	Count	Percent of Total	Count	Percent of Total
Age	18–24 yr	1,312	5.0	327	5.0
	25–34 yr	5,495	20.8	1,295	19.8
	35–44 yr	7,282	27.5	1,809	27.7
	45–54 yr	8,426	31.9	2,100	32.2
	55–74 yr	3,927	14.9	999	15.3
	Average (SD) 42.6 (10.7)[a]				
	Median 43.0[a]				
Sex	Male	18,163	68.7	4,334	66.4
	Female	8,279	31.3	2,196	33.6
Marital/Living Status	Single living alone	5,812	22.0	1,568	24.0
	Single with partner	2,020	7.6	580	8.9
	Married	18,610	70.4	4,382	67.1
Job tenure	Less than 1 yr	4,384	16.6	1,298	19.9
	1–5 yr	9,870	37.3	2,209	33.8
	6–15 yr	7,371	27.9	1,877	28.7
	Over 15 yr	4,817	18.2	1,146	17.6
Occupation	Production/maintenance	10,529	39.8	2,430	37.2
	Administrative	3,030	11.5	826	12.7
	Technician (lab/maintenance)	3,279	12.4	877	13.4
	Sales Representative	1,430	5.4	364	5.6
	Other	2,698	10.2	663	10.2
	Warehouse/Distribution	738	2.8	241	3.7
	Manager/professional	4,738	17.9	1,129	17.3
Work schedule	Day / 8 h	13,717	51.9	3,753	57.5
	Day / 10 h	3,226	12.2	835	12.8
	Day / 12 h	899	3.4	205	3.1
	Night / 8 h	1,189	4.5	358	5.5
	Night / 10 h	182	0.7	64	1.0
	Night / 12 h	193	0.7	58	1.0
	Rotating / 8 h	3,726	14.1	721	11.0
	Rotating / 10 h	440	1.7	126	1.9
	Rotating / 12 h	2,870	10.9	410	6.3
Total		26,442	100.0	6,530	24.7

[a]Values are the same for sleep respondents.

Table 2. Distribution of work schedule groups by occupational group

	N	Production/ Maintenance (%)	Administrative (%)	Technician (lab/maintenance) (%)	Sales Representative (%)	Other (%)	Warehouse/ Distribution (%)	Manager/ Professional (%)
Day / 8 h	13,717	20.3	18.5	16.4	5.0	12.5	2.9	24.5
Day / 10 h	3,226	18.3	11.0	6.9	16.2	9.8	3.1	34.7
Day / 12 h	899	45.9	4.2	3.8	17.9	8.2	1.5	18.5
Night / 8 h	1,189	72.4	1.1	13.5	0.5	6.6	5.1	0.8
Night / 10 h	182	50.6	4.4	19.2	5.0	11.5	7.1	2.2
Night / 12 h	193	82.4	2.1	7.3	0.5	6.7	0.5	0.5
Rotating / 8 h	3,726	79.1	0.7	9.1	0.8	6.2	2.8	1.3
Rotating / 10 h	440	70.0	2.1	12.7	3.4	9.1	1.8	0.9
Rotating / 12 h	2,870	82.9	1.4	5.9	0.2	7.5	1.3	0.9

Table 3. Prevalence (%) of behavioral outcomes by work schedule

		BMI > 30		Smoking		No exercise		Moderate to heavy drinking		Short sleep duration		
Work schedule	N	COUNT	%	COUNT	%	COUNT	%	COUNT	%	N[a]	COUNT	%
Day / 8 h	13,717	3,563	26.0	1,945	14.2	2,664	19.4	3,052	22.3	3,753	1,561	41.6
Day / 10 h	3,226	833	25.8	432	13.4	570	17.7	749	23.2	835	389	46.6
Day / 12 h	899	269	29.9	215	23.9	228	25.4	147	16.4	205	122	59.5
Night / 8 h	1,189	453	38.1	229	19.3	262	22.0	263	22.1	358	207	57.8
Night / 10 h	182	71	39.0	38	20.9	52	28.6	40	22.0	64	29	45.3
Night / 12 h	193	56	29.0	47	24.4	23	11.9	34	17.6	58	36	62.1
Rotating / 8 h	3,726	1,113	29.9	835	22.4	848	22.8	745	20.0	721	384	53.3
Rotating /10 h	440	126	28.6	81	18.4	108	24.5	83	18.9	126	94	74.6
Rotating / 12 h	2,870	1,000	34.8	761	26.5	756	26.3	767	26.7	410	255	62.2
Total	26,442	7,484	28.3	4,583	17.3	5,810	22.0	5,880	22.2	6,530	3,077	47.1

[a]N is lower for sleep duration because only a subset of respondents answered the sleep duration question.

Table 4. Adjusted Prevalence Ratios for behavioral outcomes by work schedule and occupational group[a]

		BMI > 30		Smoking		No exercise		Moderate to heavy drinking		Short sleep duration[b]	
Shift / Occupation	N	RR*	95%CI	RR	95%CI	RR	95%CI	RR	95%CI	RR	95%CI
Day / 8 h	13,717	1.00		1.00		1.00		1.00		1.00	
Day / 10 h	3,226	0.99	0.91–1.07	0.98	0.88–1.09	1.01	0.92–1.11	0.98	0.91–1.07	**1.12**	1.00–1.26
Day / 12 h	899	1.03	0.91–1.17	**1.58**	1.37–1.83	**1.33**	1.16–1.53	**0.73**	0.62–0.86	**1.31**	1.09–1.58
Night / 8 h	1,189	**1.26**	1.14–1.40	**1.18**	1.02–1.36	1.10	0.96–1.26	0.99	0.87–1.12	**1.22**	1.05–1.43
Night / 10 h	182	**1.38**	1.09–1.75	1.29	0.93–1.78	**1.46**	1.11–1.92	0.94	0.68–1.28	1.02	0.70–1.48
Night / 12 h	193	1.01	0.77–1.31	**1.43**	1.06–1.92	0.61	0.40–0.92	0.76	0.54–1.06	1.35	0.96–1.89
Rotating Shift / 8 h	3,726	0.98	0.91–1.06	**1.38**	1.26–1.52	**1.18**	1.08–1.28	**0.89**	0.82–0.98	**1.15**	1.02–1.30
Rotating Shift / 10 h	440	0.97	0.81–1.16	1.14	0.91–1.43	**1.25**	1.02–1.51	0.84	0.68–1.05	**1.60**	1.29–1.99
Rotating Shift / 12 h	2,870	**1.11**	1.02–1.20	**1.64**	1.49–1.80	**1.33**	1.22–1.46	**1.22**	1.11–1.33	**1.29**	1.12–1.49
Manager/professional	4,738	1.00		1.00		1.00		1.00		1.00	
Production/maintenance	10,529	**1.52**	1.40–1.65	**1.87**	1.66–2.10	**1.50**	1.36–1.66	**0.87**	0.80–0.95	**1.18**	1.05–1.33
Administrative	3,030	**1.12**	1.01–1.23	**1.86**	1.62–2.12	**1.54**	1.38–1.72	0.92	0.83–1.02	0.92	0.80–1.07
Technician –(lab/maintenance)	3,279	**1.17**	1.07–1.29	**1.87**	1.64–2.12	**1.56**	1.39–1.74	**0.90**	0.81–0.99	0.97	0.84–1.11
Sales Representative	1,430	**1.22**	1.08–1.37	**2.13**	1.82–2.49	**1.52**	1.31–1.75	1.00	0.89–1.13	0.86	0.71–1.04
Other	2,698	**1.50**	1.37–1.65	**1.89**	1.65–2.16	**1.81**	1.62–2.02	**0.84**	0.75–0.93	1.06	0.92–1.23
Warehouse/Distribution	738	**1.49**	1.29–1.72	**1.82**	1.49–2.22	**1.64**	1.38–1.95	0.90	0.76–1.06	1.17	0.96–1.43

[a]One model for each behavioral outcome. Rate ratios for work schedule groups are adjusted for occupational group, age, gender, job tenure, and marital/living status. Rate ratios for occupational groups are from the same model, and are adjusted for schedule group, age, gender, job tenure, and marital/living status. Statistically significant results in bold type.–[b]Multiple regression model for short sleep duration is implemented with a subset of respondents who answered a question on sleep (N=6,530).

All work schedule groups other than the 10-h days had adjusted smoking rates that were higher than the 8-h day shift. All of these differences were statistically significant, except for the 10-h rotating shift. The highest rate ratios were found for the 12-h day and rotating shifts (RR=1.6), and several other shifts had RRs of 1.3 to 1.4. Since the rate of smoking among 8-h day shift employees was 14.2%, RRs of 1.3 and 1.6 represent an additional 4.3% and 8.5% in these shifts who are smokers, on an adjusted basis[3].

A higher prevalence of "no exercise" was associated with all the rotating shift schedules (RRs=1.2 to 1.3) and with 12-h day schedules (RR=1.3). Results for the night shifts were mixed. The 8-h day employees

[3]In an alternative analysis, "heavy smoking" was defined as smoking 1) 1 or more packs of cigarettes each day, 2) 3 or more packages of pipe or loose tobacco in a week, or 3) 10 or more cigars in a week. Prevalence among 8-h day employees was 4.2%. Heavy smoking rates were about twice as high for 12-h day, night, and rotating shift workers (RRs between 1.9 and 2.1). Higher heavy smoking rates were also found for 8-h rotating shift workers (RR=1.4, statistically significant) and for 8 and 10-h night shift workers (RR=1.2, not statistically significant).

had a rate of "no exercise" of 19.4%, so an RR of 1.3 represents an additional 5.8% getting no exercise, on an adjusted basis.

Obesity (BMI≥30) was associated with 8-h night shifts (RR=1.3) and 10-h night shifts (RR=1.4) and with 12-h rotating shifts (RR=1.1). Since the rate of high BMI among 8-h day shift employees was 26.0%, an RR of 1.3 represents an additional 7.8% of the 8 and 10 h night shift workers who are obese, after adjusting for other differences in their characteristics.

Only the 12-h rotating shift group had a higher rate of moderate to heavy alcohol consumption than the 8-h day shift (RR=1.2). Four other schedule groups (12-h day, 12-h night, 8-h rotating, 10-h rotating) had a lower rate of consumption than the 8 h day group with RRs of about 0.7 to 0.9 (12-h day and 8-h rotating statistically significant).

Discussion

Interpretation of findings

The findings clearly supported the hypotheses that non-standard work schedules were associated with less healthy sleep, smoking, and exercise behaviors. Not surprisingly, the 10-h day shift had rates of unhealthy behaviors that were the most similar to those of the 8-h day shift. For the other 7 non-standard schedules, the adjusted RRs for short sleep duration, smoking, and lack of exercise, showed less healthy behaviors than the 8-h day shift in 19 out of 21 cases, 15 of which were statistically significant. The exceptions were mostly for three schedule groups with much smaller numbers and thus less power to detect significant differences. BMI over 30 was not generally associated with 12-h shifts or rotating shifts as hypothesized, but was associated with 8 and 10-h night shifts. The hypothesis of higher alcohol consumption was supported only for the 12-h rotating shift, whereas several other schedule groups had lower alcohol consumption than the 8-h day shift (2 of them by a statistically significant amount). The two work schedules hypothesized to have the most unhealthy behaviors were the 12-h night and 12-h rotating schedules. In fact, the 12-h rotating group was the only one to have statistically significant elevations of all five unhealthy behaviors, and in all except one case, it had the highest or close to the highest elevation among the schedule groups. In contrast, the 12-h night group had an elevation of only two unhealthy behaviors, one of which was statistically significant. However, this group was one of the two smallest groups and may have had special characteristics since it was unique in its degree of concentration in a very few sites.

The observed overall rate of short sleep duration defined as sleep of 6 h or less per day (47%) was higher than the rate for all U.S. employees (29.9%) and for U.S. manufacturing sector employees (34.8%) (2004–2007 data)[39]. The finding that demanding work schedules are associated with higher rates of short sleep duration is in agreement with the predominant findings in previous studies and supports the theory that shift work and long shifts negatively impact health and safety through restricting and disturbing sleep[10]. The observed association of higher smoking rates with non-standard schedules could be due to attempts to counteract fatigue and stress, while lack of exercise could be due to difficulties in scheduling exercise or feeling too tired to exercise. High BMI among night workers could be due in part to lack of access to healthy food, lack of exercise opportunities, or sleep disturbance's impact on hunger hormones[12]. Lower alcohol consumption among some groups of non-standard shift workers may be due to fewer social opportunities for drinking or less desire to drink due to sleepiness associated with long shifts and circadian rhythms.

Limitations

The HRA used for this analysis has some limitations. First, response is voluntary, and several modules were optional for those who chose to take the survey. Personal as well as location-specific factors would have affected tendency to participate. Second, a true response rate cannot be calculated. While the number of respondents (31,234) and the number of those with responses complete enough for analysis (26,442) were high in relation to the peak workforce of 34,000 before a major acquisition near the end of 2008, they were not as high in relation to the total number of people who worked for the manufacturer during 2000–2008. The workforce was relatively stable during 2000–2007, but the turnover rate and total number of employees during this period are not known.

Those who chose to respond to the optional stress module that included the sleep hour question were less than 25% of those who fully responded to the survey core. If those who chose not to take the stress module were different than others, this could have biased the results on sleep. For example, this could have occurred if respondents to this module tended to have more stress, or in contrast, felt less pressed for time, and if these characteristics were associated both with certain work schedules and sleep duration.

The question on sleep hours may have elicited some inaccurate responses because it asked how many hours the respondent usually slept at night. Some respondents on a night schedule could have reduced their estimates, because they sleep during the day, which may have led

to over-estimation of the prevalence ratio. However, we would expect night workers to translate the question correctly.

The finding that reported alcohol use was higher among managers and professionals and in the 8-h day shift might possibly add to concern about the accuracy of alcohol question responses. However, respondents only needed to admit to fairly modest use to be included in the category of moderate to heavy drinking. Another potential concern is that random drug testing of the study population over most of the period of the survey might possibly have influenced responses, but alcohol testing was done only in response to evidence of working while intoxicated.

Rate ratios could not be fully adjusted for all differences between work schedule groups. Occupational classifications differed strongly in rates of some behaviors and were important to the adjustment. This suggests that it would have been better to have a somewhat finer classification of occupations[4]. Other differences in work schedule populations that correlate with health behaviors may well exist. One way of accounting for such differences would have been to adjust for individual locations. However, we chose not to do so, since locations would tend to specialize in particular work schedules, making it hard to distinguish between the effect of location and schedule. We examined whether there is an effect of country, although the majority of locations would have been in the U.S. When a mixed effect model was applied for smoking using country as a random effect, the results showed virtually no changes in the regression coefficients. For other outcomes, we had difficulty with convergence of models because of small numbers of locations in many countries.

There were at least three key gaps in the types of information available in the HRA survey. One was the lack of information on hours of work per week which has been strongly related, in past studies, to the behaviors we examined. We could not differentiate schedules that combined longer shifts with high hours per week from schedules with longer shifts but fewer work days. Another limitation was lack of HRA data for sleep quality. Sleep disorders are common. For example, 20% of Detroit-area workers reported insomnia or excessive sleepiness[17]. Poor sleep quality may promote unhealthy behaviors, and there is some evidence that sleep apnea promotes obesity[40]. Finally, the data lacked details on the speed and pattern of shift rotation which would have been very helpful, since these factors are thought to greatly influence the effects of rotation.

This study also shares the basic limitations of any cross-sectional analysis. A longitudinal analysis could compare locations that change their work schedules in different ways, and this might be a future possibility as more respondents retake the survey at multiple points in time. However, if some employees are able to choose their schedules and are influenced by difficulties of adapting to certain schedules, we would expect longitudinal analysis to show stronger associations of schedules and behaviors than were found in this study.

Implications for safety and health practice

One of the purposes of this study was to obtain information that could inform decisions about efforts to improve employee safety and health. The pattern of increased risk of short sleep, smoking, high BMI, and lack of exercise among employees on non-standard work schedules, suggests considering a range of interventions. Short sleep hours could be most directly addressed by workplace policies and improvements to the design of work schedules (e.g. limiting overtime and consecutive work days, minimizing night work, adjusting start times, avoiding backward shift rotations, etc.)[41–43]. In addition, an educational intervention targeted to all levels of employees, including managers, could increase knowledge and awareness of the role and importance of sleep in health, and provide information for design of sleep supportive policies as well as improved sleep practices (e.g. controlling light and noise, establishing strong sleep schedule priorities, educated and limited use of sleeping aids, treatment for sleep disorders, etc.)[43–45]. Due to the widespread lack of awareness of the health and safety risks of poor sleep, the need for developing and testing sleep education programs has been emphasized by the sleep research community[46, 47]. Since the prevalence of short sleep hours was so high in this population, even among 8-h day shift workers (42%), it would be reasonable not to restrict sleep education to those on schedules with the highest rates of short sleep duration.

[4]One question in the survey that provided more detail on the nature of occupation was the following: Does your job require you to be highly physical? (Yes/No) The same models were employed with the addition of this variable, but the subset of workers who answered this question was small (N=1,535). The results were generally robust to this change. The physicality of jobs had essentially no relationship to sleep, exercise, or smoking in the context of the model, but jobs that were not physically intensive were associated with higher alcohol consumption (RR=1.4) and somewhat higher rates of high BMI (RR=1.2). Most of the schedule differences for alcohol were similar to those in the whole sample model, except those for 10 and 12-h rotating shifts which were associated with somewhat higher RRs. High BMI results for the 8 and 10-h night shifts increased from 1.3 to 1.6.

High smoking and BMI, and low exercise rates may be addressed by standard health promotion programs, but special barriers to adopting or maintaining better behaviors among non-standard shift workers might also be identified and addressed through various other policies and programs. Efforts outlined above to facilitate better sleep may be helpful. In addition, if lack of sleep and fatigue are leading some workers to smoke to maintain alertness, then fatigue countermeasures may also be helpful. Examples of such countermeasures include encouraging more frequent short breaks, more flexible breaks, or naps, adjusting light exposure, reducing monotony, and encouraging limited and strategic use of caffeine, and eating patterns that maintain stable blood glucose[42, 44, 45, 48–50]. Smoking policies and cessation incentives and supports may also be examined in relation to their effectiveness for employees on non-standard shifts. If work schedules interfere with exercise for some shift workers, it may be possible to make exercise facilities more accessible or schedules more accommodating; and if healthy eating patterns are discouraged by limitations in conveniently available options, then better options might be added or substituted.

Conclusions

Long shifts and night and rotating shifts were observed generally to be associated with less sleep and more smoking. In addition, night shifts were generally associated with higher BMI, while long shifts and rotating shifts were generally associated with lower exercise. Shifts that were both long and rotating had the most consistent pattern of unhealthy behaviors. These associations were observed in readily available HRA survey data that are available to many employers, suggesting that other employers should consider looking for similar patterns and guidance in their HRA data. Where HRAs lack data on sleep and details of work schedules, additional questions should be considered. Additional investigation is needed into the sources of work schedule differences, and further effort should be targeted at reducing the additional health burden associated with non-standard work-schedules.

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